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Original Research

Total Knee Arthroplasty Is Superior to Open Wedge High Tibial Osteotomy in Terms of Pain Relief for Patients With Osteoarthritis

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ABSTRACT

Background: Globally, total knee arthroplasty (TKA) is widely performed on patients with osteoarthritis. Meanwhile, open wedge high tibial osteotomy (OWHTO) has garnered attention in our country as a joint-preserving procedure. This study aimed to retrospectively compare the postoperative clinical outcomes of TKA and OWHTO for patients with osteoarthritis.

Methods: We selected 94 patients (106 knees) who underwent OWHTO or TKA between 2013 and 2018, had complete clinical data, and were followed up for >2 years. Patients were classified into 2 groups depending on the procedure (TKA: n = 49; OWHTO: n = 45). Patients in the A (= arthroplasty) group were significantly older, with a worse range of motion (ROM) than those in the O (osteotomy) group. There were no significant differences regarding sex and body mass index between groups. Operative time, perioperative blood loss, knee ROM, and Japanese Knee Injury and Osteoarthritis Outcome Score (J-KOOS) were compared between the groups.

Results: Significant differences were found between the A and O groups regarding operative time (120 ± 27.2 vs 80.3 ± 23.3 minutes), perioperative blood loss (505.4 ± 271.8 vs 322.6 ± 196.1 mL), knee ROM (flexion; 123.4 ± 16.3° vs 133.7 ± 12.8°), and J-KOOS for pain (87.4 ± 12.5 vs 78.1 ± 15.2 points) and symptoms (86.6 ± 12.3 vs 79.1 ± 13.3 points). There were no significant differences regarding other J-KOOS subscales.

Conclusions: OWHTO involved shorter operative times and less blood loss. However, the O group reported less pain relief. The A group represents an older, likely less active patient population. Therefore, OWHTO is a possible joint-preserving treatment options in younger active patients who may not be interested in arthroplasty.

Introduction

Total knee arthroplasty (TKA) is widely performed for patients with osteoarthritis (OA). It was reported that the 15-year survival rate for elective TKA was 95.9%, which worsened to 82.3% at 25 years [1,2]. Japan is well on its way to an unprecedented elderly society, with an average life expectancy of 81.25 years for men (ranked third in the world) and 87.32 years for women (ranked second in the world). It is preferable to delay performing TKA for Japanese patients, especially women, because of the possibility of requiring revision surgery in the future. Therefore, around knee osteotomy for these patients, with OA as a joint-preserving procedure, has garnered attention in Japan; the debate regarding the development and improvement of surgical techniques is ongoing. Joint-preserving procedures are useful as they allow patients to continue performing sports or recreational activity without any limitations, promote the ability to perform activities of daily living,

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and allow for a quality of life (QOL) as well as or better than experienced preoperatively [3-6]. However, some patients claim a certain degree of residual pain and other symptoms, instead of joint preservation.

This study aimed to retrospectively compare the postoperative clinical outcomes of TKA and open wedge high tibial osteotomy (OWHTO) for patients with OA and research the advantages and disadvantages of both procedures.

Material and methods

This study was approved by the institutional review board for clinical research of our university (no. 19R139). Patients and their families were informed that data from the case would be submitted for publication, and they provided their consent for us to do so.

We selected 98 patients (114 knees) with OA who underwent OWHTO or TKA at our institution between 2013 and 2018, had complete clinical data, and were followed up for more than 2 years. Among them, 94 patients (106 knees) were included as study candidates; 4 patients (8 knees) who underwent OWHTO and TKA for each knee were excluded.

Patients were classified into 2 groups. Forty-nine patients (58 knees) who underwent TKA comprised the A group, while 45 patients (48 knees) who underwent OWHTO comprised the O group. The follow-up period was 36.6 ± 16.1 months for the A group and 33.1 ± 14 for the O group.

Our indications for OWHTO were isolated medial femorotibial joint OA, intact lateral femorotibial joint, no or mild patellofemoral (P-F) joint OA, and femorotibial angle (FTA) <185°. There were no age or body weight limitations. We performed OWHTO as described by Takauchi et al [3]. After biplane (oblique and proximal tuberosity) osteotomy of the tibia, artificial bone was transplanted to the opening gap and fixed at the osteotomy site using TomoFix (DePuy Synthes, Bettlach, Switzerland) or TriS (Olympus Terumo Biomaterials, Tokyo, Japan). One week after surgery, patients were allowed to begin partial weight-bearing exercises; full weight-bearing walking was started at 2 weeks after surgery. One year after the index surgery, all patients underwent implant removal.

We performed TKA if the patients did not meet any of the requirements of our around knee osteotomy indication criteria. As a result, almost all patients exhibited not only medial, but lateral femorotibial joint or tricompartment OA, including the P-F joint. The mini-subvastus or mini-parapatellar approach was used without eversion of the patella. The MIS Quad-Sparing instrumentation (Zimmer Biomet Holdings Inc., Warsaw, IN) was used while cutting the femur and tibia from the medial side. The posterior cruciate ligament was sacrificed, and the patella was resurfaced in all cases. We implanted cemented NexGen Legacy Posterior-Stabilized Flex (Zimmer Biomet Holdings Inc.). Patients began full weight-bearing walking as soon as possible after surgery.

The following background variables were compared between the groups: age, sex, body mass index, preoperative knee range of motion (ROM), FTA, operative time, perioperative blood loss, postoperative knee ROM, the Japanese Orthopedic Association knee rating score (JOA score), and Japanese Knee Injury and Osteoarthritis Outcome Score (J-KOOS). The operative time, perioperative blood loss, and knee ROM were captured during the chart review. The JOA score and J-KOOS were measured at the final follow-up examination. The KOOS is a useful validation tool that appears to be increasing in popularity [7,8]. It is a 42-item knee-specific questionnaire with 5 separately reported subscales: pain, other symptoms, function in daily living, function in sports/recreation, and knee-related QOL. A Likert scale is used, and all items have 5 possible answer options with scores from 0 (no problems) to 4 (extreme problems). Subscale scores represent the average of all items of the subscale standardized to a score from 0 to 100 (worst to best). The J-KOOS was developed according to the standard cross-cultural adaptation guidelines and has been confirmed as a reliable and stable outcome measure that provides a valuable basis for national and international clinical projects focusing on patient-based assessments of knee OA [9].

Statistical analyses were performed using SPSS Statistics software (v. 22; IBM, Armonk, NY). Variables were compared between the 2 groups using the Student's t test or chi-squared test; $P < .01$ was considered significant.

Results

Patients in the A group were significantly older (74.5 ± 5.4 vs 64 ± 6.8 years) and had a worse preoperative ROM (flexion: 118.7 ± 18.7° vs 131.7 ± 10.6°, extension: −6.2 ± 6.6° vs −2.5 ± 4.4°) than those in the O group. There were no significant differences regarding sex, body mass index, or FTA between the groups (Table 1).

Significant differences were found between the A and O groups in terms of operative time (120 ± 27.2 vs 80.3 ± 23.3 minutes), perioperative blood loss (505.4 ± 271.8 vs 322.6 ± 196.1 ml), knee ROM (flexion: 123.4 ± 16.3° vs 133.7 ± 12.8°), J-KOOS for pain (87.4 ± 12.5 vs 78.1 ± 15.2 points), and J-KOOS for symptoms (86.6 ± 12.3 vs 79.1 ± 13.3 points). There were no significant differences in terms of the JOA score and other J-KOOS subscales (Table 2).

According to detailed analysis of the J-KOOS subscales of each questionnaire, significant differences were observed for P1 and P6 (pain), as well as for S2 and S6 (symptoms). P1 in the O group had the highest (worst) scores (2.2 ± 1.2) for the pain and symptom subscales (Table 3).

Discussion

OWHTO involved shorter operative time and less blood loss. It also promised to improve the ability to perform activities of daily living and QOL, performing either as well as, or better than TKA; however, the present study found the O group reported less pain relief than the A group, especially when going up or down the stairs. Moreover, residual symptoms such as knee grinding, clicking, and stiffness were worse after OWHTO than they were after TKA.

A number of reports of postoperative outcomes using the KOOS for OWHTO or TKA have been published [10-19]. As published by Roos and Lohmander [20], the KOOS score represents clinically significant results, as the difference between the 2 groups was greater than the minimal clinically important difference reported in the literature [8-10]. According to these previous reports, the KOOS for pain was 73.3–85 points (mean) for OWHTO and 77.2-94 for TKA. Furthermore, the KOOS for symptoms was 58.8-84.6 for OWHTO and 75-95 for TKA. TKA has been considered superior in

Table 1
Preoperative data.

	A group, n = 49	O group, n = 45	P value
Age, years	74.5 ± 5.4	64 ± 6.8	<.01[a]
Sex, male/female	18/31	20/25	.45[b]
BMI, kg/m^2	25.4 ± 3.2	25.6 ± 3.6	.61[a]
Knee ROM			
Flexion	118.7 ± 18.7°	131.7 ± 10.6°	<.01[a]
Extension	−6.2 ± 6.6°	−2.5 ± 4.4°	<.01[a]
Femorotibial angle	183.5 ± 9.4°	180.7 ± 3.1°	.08[a]

BMI, body mass index; ROM, range of motion.
Data are represented as mean ± SD. P value was calculated using the Student's t test (a) or chi-squared test (b).
There were significant differences in terms of age and ROM.

Table 2
Perioperative and postoperative data.

	A group	O group	*P* value
Operative time, minutes	120 ± 27.2	80.3 ± 23.3	<.01
Perioperative blood loss, mL	505.4 ± 271.8	322.6 ± 196.1	<.01
Knee ROM:			
Flexion	123.4 ± 16.3°	133.7 ± 12.8°	<.01
Extension	− 0.8 ± 1.9°	− 1 ± 3.3°	.76
JOA score	86.8 ± 6.3	87.1 ± 10.2	.86
J-KOOS, pain	87.4 ± 12.5	78.1 ± 15.2	<.01
J-KOOS, symptoms	86.6 ± 12.3	79.1 ± 13.3	<.01
J-KOOS, ADL	83.6 ± 11.6	84.3 ± 12	.74
J-KOOS, sports/recreation	43.4 ± 28.7	51.4 ± 28.8	.16
J-KOOS, QOL	56.4 ± 22	62.5 ± 18.8	.12

ADL, activities of daily living; JOA, Japanese Orthopedic Association; KOOS, Knee Injury and Osteoarthritis Outcome Score; QOL, quality of life; ROM, range of motion. Data are represented as mean ± SD. *P* value was calculated using the Student's *t* test. There were significant differences in terms of operative time, perioperative blood loss, ROM, J-KOOS for pain, and J-KOOS for symptoms.

terms of pain relief and symptom improvement, as noted in this study. Recently, Matsumoto et al. [21] directly compared the KOOS for both procedures and found that the KOOS for pain and symptoms were significantly higher in the TKA group (89.9 ± 6.4 and 87.5 ± 11.3) than those in the HTO group (80.3 ± 12.5 and 80.0 ± 15.1), which were consistent with our findings.

There were significant differences in terms of the questions P1 and P6, as well as S2 and S6, as described in Table 3. In our opinion, joint inflammation or fluid collection may have occurred with OWHTO, instead of preservation of the patients' own articular cartilage, synovial tissues, and meniscus. Furthermore, we performed proximal tuberosity osteotomies for all cases in this study. P-F joint pressure increases, and articular cartilage damage progresses after proximal tuberosity osteotomy [22-24]. In addition, P-F joint reaction forces gradually increased up to 90° of knee flexion and can reach up to 8 times the patient's body weight, depending on the type of activity (ie, stair climbing, squatting, and so on) [25]. The patella was resurfaced in all patients in group A. The P-F joint symptoms were possible causes of the differences in clinical outcomes between the groups. Several surgical techniques have been developed to reduce adverse effects on the P-F joint, such as open wedge distal tuberosity tibial osteotomy [6,26,27] and hybrid closed wedge high tibial osteotomy [4], which are becoming mainstream procedures. A comparative study of these and current techniques is warranted.

The present study found TKA was superior to OWHTO in terms of pain relief. The findings help surgeons counseling younger, more active patients considering both procedures with a better understanding of both the advantages and disadvantages. Previous studies have reported on postoperative changes such as patellar baja, which may complicate OWHTO patients who subsequently undergo TKA. Future studies are needed to determine the viability of OWHTO as a joint-preserving surgery, particularly in younger active patients. Furthermore, joint replacement surgery should be considered for patients with low activity levels and lower expectations concerning sport and recreation.

Table 3
Detailed analysis of the Japanese Knee Injury and Osteoarthritis Outcome Score subscale of each questionnaire.

	A group	O group	*P* value
P1. How often is your knee painful?	0.8 ± 1.2	2.2 ± 1.2	<.01
P6. What degree of pain do you feel when going up and down stairs?	0.7 ± 0.8	1.3 ± 0.9	<.01
S2. Do you feel grinding, hear clicking, or any other type of noise when your knee moves?	0.5 ± 0.9	1.3 ± 1.1	<.01
S6. How severe is your knee stiffness after first waking in the morning?	0.5 ± 0.8	1.1 ± 0.8	<.01

Data are represented as mean ± SD. *P* value was calculated using the Student's *t* test. Significant differences were observed for P1 and P6, as well as for S2 and S6.

This study had several limitations. First, the number of patients included was small. Second, this was not a prospective study. Third, the magnitude of improvement after surgery compared with the preoperative status could not be compared because the preoperative J-KOOS could not be evaluated. Fourth, there were significant differences between the backgrounds of patients in both groups; for example, patients in the O group were 10 years younger than patients in the A group. Likewise, lateral compartment arthritis was an exclusion criterion for OWHTO. Therefore, the O group was likely more active, with higher functional expectations and demands. This is an inherent and the biggest limitation of this study.

Conclusions

We conclude that TKA is superior to OWHTO in terms of pain relief, especially when going up or down the stairs. Moreover, residual symptoms such as knee grinding, clicking, and stiffness are better after TKA than they were after OWHTO.

Declaration of interests

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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